SCIENCE:

A Weekly Record of Scientific Progress.

JOHN MICHELS, Editor.

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SATURDAY, JULY 23, 1881.

Professor Lewis Swift informs us that he has been receiving letters claiming the Warner Prize, at the rate of seventy per day for some time past; it may be convenient, therefore, if we state the conditions on which Mr. Warner offers the reward for the discovery of comets during the year 1881.

In the first place the comet must be telescopic, which is a bar to all naked eye observers, and the comet must be unexpected. An exception is made to this condition in favor of the comet of 1812, the reappearance of which is expected.

The first discovery of the comet must be made in the United States or Canada. To secure the prize immediate notification must be made by telegraph to Professor Lewis Swift, of Rochester, Director of the Warner Observatory. This telegram must give the time of the discovery, the position, direction and daily rate of motion with sufficient exactness to enable at least one astronomer to find it.

A study of these conditions will prevent useless applications and many disappointments. The first condition, however, which appears to limit claimants to the class who possess telescopes, should, in our opinion, be construed to object to naked eye observations only. A good opera or field binocular glass could be used with good effect in a search for comets. Caroline Herschell used a very simple instrument, and, in the course of her life, discovered no less than eight comets. With a tube with two glasses, such as was commonly used "as a finder," she used to "sweep" for comets, writing down and describing all remarkable appearances.

We direct attention to a series of interesting drawings of comet B, 1881, made by Professor Edward S. Holden at the Washburn Observatory, with the 15-inch telescope, constructed for the late Professor Watson, which will be found on pages 346 and 347 of this issue.

Professor Holden has attempted to delineate the appearance of the comet on six consecutive nights, commencing on the 24th of June, and also on the 8th and 11th of July.

Messrs. S. E. Cassino & Co., of 299 Washington street, Boston, are about to publish an international directory of the names and addresses of all those who are engaged in any of the departments of Science. Such a work can only be arranged in a satisfactory manner with the co-operation of scientific men. We therefore cordially respond to a request from Messrs. Cassino to make known their intentions in this direction, and we call upon all scientists at once to forward their names and addresses to the publisher.

This notice is not only intended for professional scientists, but for the large class of amateurs, who may be collecting, or giving their attention to any scientific specialty.

As the directory is partly prepared, prompt attention is essential to those who would have their names included.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

We remind our readers that the annual meeting of the American Association for the advancement of Science will be held this year at Cincinnati, commencing on the 17th of August next. The executive committee announce that the sessions of the Association will be held in the Music Hall and Exposition Buildings, on Elm street. All the meetings, general and sectional, will be under one roof. Each section will have a room regularly assigned to it, and every necessary facility in the way of tables, blackboards, etc., will be provided. The offices of the Permanent and Local Secretaries, Reporters' Room, Post Office and Reception Rooms will all be on the first floor. Between the morning and afternoon sessions a daily lunch will be served in the wing of the Exposition Buildings known as Horticultural Hall.

On the first day of the meeting, besides the general session for organization, some of the official addresses will be delivered. In the evening there will be a citizens' reception.

On the following days the usual routine business will be transacted, papers will be read, and so on. A variety of social entertainments will be provided, and an afternoon is to be devoted to visiting the Zoological Garden.

Members of the Sub-Section of Anthropology, and others who are interested, will have an opportunity to examine the excavations at Madisonville, and to visit other localities of antiquarian interest near Cincinnati. After the adjournment of the Association, excursions will be organized on the Cincinnati Southern Railroad, and also, it is hoped, to the Mammoth Cave.

Beginning on the evening of August 16, and continuing through the meetings of the Association, there will be an exhibition of scientific apparatus, appliances, and collections. This exhibition is to be in charge of the Department of Science and Arts of the Ohio Mechanics' Institute, and a large amount of valuable material will be shown. Some of the leading dealers in chemicals, ap-

paratus, microscopes, minerals and zoological specimens have already notified the Special Committee of their intention to exhibit. The goods here displayed are to be kept over for the Ninth Cincinnati Industrial Exposition, opening September 7, the Managers of which have offered special premiums for this class of exhibits.

The local executive committee comprises the following names: A. T. Goshorn, Chairman; F. W. Clarke, Ormond Stone, Secretaries; Julius Dexter, Treasurer; J. D. Cox, William McAlpin, Herbert Jenney, George W. Jones, Archer Brown, C. W. Wendte, Robert Brown, Jr.

CONTRIBUTIONS TO COMPARATIVE PSYCHOLOGY.

By S. V. Clevenger, M. D.

II. LANGUAGE.

Excepting in Kussmaul's (1) elaborate essay, speech has had but little consideration anatomically and physiologically. The philologists and ethnologists have been trying to interpret phenomena while ignoring the mechanism directly concerned therein. As readily might the operations of a locomotive be explained by a person who had never seen one. Herbert Spencer, on the origin of language, is discursive and inconclusive. Darwin passes hastily over the subject in his "Descent of Man," but later (2) lays the foundation for a proper study. Bastian may be taken as the representative of the majority expressing opinions on language (3). He says: "Language was started by some hidden and unknown process of natural development or as a still more occult God-sent gift to man." If inquiries are to terminate in such assumptions, why not extend our conceptions of occult God-sent gifts, to the explanation of the Universe? Bastian's words mean, "I cannot fathom it, therefore, no one should try to do so."

Mivart (4) adopts the usually accepted divisions of language:

I. Sounds which are neither articulate nor rational, such as cries of pain, or the murmur of a mother to her infant.

II. Sounds which are articulate, but not rational, such as the talk of parrots, or of certain idiots, who will repeat, without comprehending, every phrase they hear.

III. Sounds which are rational, but not articulate, such as the inarticulate ejaculations by which we sometimes express assent or dissent from given propositions.

IV. Sounds which are both rational and articulate, constituting true speech.

V. Gestures which do not answer to rational conceptions, but are merely the manifestations of emotions and feelings.

VI. Gestures which do answer to rational conceptions and are, therefore, external, but not oral manifestations of the *mental* word. Such are many of the gestures of deaf mutes, who, being incapable of articulating words, have invented or acquired a language of gesture.

Analyzing these divisions, we find therein the prevailing idea to be that:

I. Language consists of speech and gesture (This essay will be directed toward proving that speech is also gesture; hence *Language is gesture accompanied, or not accompanied with sounds*).*

II. Language is voluntary or involuntary.

An impassable gulf exists between the voluntary and the involuntary in the minds of those who are disposed to reverence authority more than logic. The history of human thought proves Agnosticism to be a far better friend to man than Vaticanism or its disguises. Huxley (5) concludes that "We are conscious automata endowed with free will in the only intelligible sense of that much-abused term—inasmuch as in many respects we are able to do as we like—but none the less parts of the great series of causes and effects, which in unbroken continuity, composes that which is, and has been, and shall be—the sum of existence. As to the logical consequences of this conviction of mine, I may be permitted to remark that logical consequences are the scarecrows of fools, and the beacons of wise men. The only question which any wise man can ask himself, and which any honest man will ask himself, is whether a doctrine is true or false?" Kussmaul (6) feels justified in claiming that "each act of the will is always also the realization of a movement image previously sketched out in the recollection, or an entire chain of such movement images." * * * "*What we call the will is not only a motor, but always a sensory process.*" That which is involuntary in our actions appears, neurologically speaking, to be most evidently reflex, and those who know most about the mechanism of the will, know also that it is none the less reflex for being complex, or for having evaded the analysis of dualists and those ecclesiastically biased. It is from this automatical basis that I seek an explanation for the hitherto inexplicable. Brown-Sequard insists that speech is a reflex phenomenon (21). We find certain muscles, tendons, bones and cartilages concerned in mastication, and deglutition of food common to many vertebrates. Many of these same parts, separately or conjointly, prove useful to these animals in noise production: A woodpecker (7) finds by drumming rapidly upon a sonorous piece of wood, that he excites the admiration of his kind, and attracts attention to himself. When he repeats the operation for the distinct purpose of exciting admiration and attracting attention, he uses as much and precisely the same kind of reason, as the serenader, who pours out his rhyme to the jingle of a guitar. Wilder (8) speaks of the inharmonious feline nocturnes, and *Lieder ohne Worte*, but cats to whom that sort of music is addressed, find it quite as rational and expressive as the seranaded biped, and the greater part of both sorts of caterwauling, may be interpreted to mean the same thing, inharmonious only to those not interested.

Thus the brays, snorts, shrieks, grunts, etc., of the myriad kinds of animals are only methods for expressing their satisfaction or displeasure. Many such sounds being made use of after their accidental origination. The North American Indian uses the hoggish grunt in affirmation, and a perusal of Darwin's "Expression of the Emotions in Man and Animals" would be profitable to philologists who are not too strongly permeated by a metaphysical bias. At the outset any animal having observed that its noises, of whatever origin, attract attention of other animals would be led to the use of such noises as are serviceable. All that follows is simply an improvement upon these conceptions, and the animal that uses one noise or gesture, or a thousand, to bring itself into relation with other animals, expresses, in so doing, an idea, conveys a thought and hence speaks.

But this matter of reason and language possessed by animals has been ably worked out by observers and thinkers (9).

When water in an engine boiler is low and the alarm whistles through a simple float device; or when portions of machinery jar and scrape, the necessity for more water or oil is conveyed to the engineer's mind, and by a means comparable to the mechanism of crying. Just so the colony of beavers dive out of sight when they hear the warning slap of the sentinel's tail.

* No attempt at a perfect definition is made here. In fact the impossibility of absolute definiteness, in a world where everything is relative, seems, in this instance, not to have occurred to the metaphysicians. Language, owing to its blending of voluntary and involuntary, and consisting of gestures, used thoughtlessly, as well as those for expressing thought, is inseparable from other animal activities. One definition of Life is that it consists of Motion, but everything moves, hence everything lives, and there is no such thing as Death. Even the mathematical definition of a point is absurd and unthinkable. Who can define Health or Disease satisfactorily?

Professor Whitney, of Yale (10), thinks that "there needs to be, perhaps, a radical stirring up of the subject, a ventilation of a somewhat breezy, even gusty order, which shall make words fly high and noisily against one another before agreement shall be reached. If so, the sooner it is brought, in whatever way, the better; and they are no true promoters of the progress of Science who strive to smooth things over on the surface and act as if all were serene and accordant below." The gentleman just quoted might have made short work of his opponents had he approached the controversy physiologically.

M. Renan (11) says: "Languages have sprung forth completely formed from the very mould of the human spirit like Minerva from the head of Jupiter." Schleicher, Steinthal and Müller are guilty of similar puerilities. The latter claims that "animals cannot talk because they have no general ideas; they evidently have no general ideas because they do not talk." This sort of reasoning might be pardonable in scholars of metaphysical tendencies, but when we find Carl Vogt refusing to deal with the question, and Haeckel (12) saying, "Our ape-like progenitor very probably did not possess an articulate language of ideas," the appearance of this essay does not seem to require an apology. To deny, as Mivart (13) does, that "the cat, or any other beast or bird" has the gift of speech, and to base this denial upon man having a peculiar language of sounds and gestures to express his thoughts, is quite as sensible a proceeding as for the woodpecker to taunt man with his inability to drum in its peculiar way. "Psychology," says Mivart, "denotes the study of all the activities, both simultaneous and successive, which any living creature may exhibit." Mivart, therefore, is the grossest kind of materialist, without knowing it, for "Psyche," after this definition, consists of motion alone, and this pre-supposes a material origin. Kruse (14) mentions a deaf and dumb lad who, after having acquired a gesture language, told of years of abuse to which he had been subjected by an inhuman father and narrated other details of his previous life. Kussmaul cites this as an evidence of the speech faculty, upon its creation, finding everything prepared for it in the way of ideas to convey. The phylogenesis of speech should be studied by proper consideration of such facts. The dog only needs human speech to tell in words what he thinks and expresses in every other way beside when his master takes a gun to start on a hunt for game.

We may set aside all consideration of sound in language by remembering that persons entirely deaf may converse in the regular way, "judging of what was said by the movements of the lips and tongue, which they had learned to connect with particular syllables; and regulating their own voices in reply by their voluntary power, guided in its exercise by their muscular sensations" (15).

Speech therefore is the same as any other muscular act under the control of the will. The jaw is a limb, the parts accessory to which and concerned in its movements are as susceptible of cultivation as is the arm, and in the matter of speech acquisition, and the gradually better and better subjection to the mind of all bodily parts concerned in its expression. Herbert Spencer's words are applicable though the passages here given had no reference to the point under consideration:

"Functions, like structures, arise by progressive differentiations just as an organ is first an indefinite rudiment having nothing but some most general characteristic in common with the form it is ultimately to take; so a function begins as a kind of action, that is like the kind of action it will eventually become, only in a very vague way." (16) Thus a "lecture" by the Rev. Joseph Cook was predetermined by the bark of the primordial dog. (Vogt says "let them bark, it is their nature.")

"In animals, however, besides analogously structural changes wrought during the period of growth by subjection to circumstances unlike the ordinary circumstances, there are structural changes similarly wrought after maturity has been reached. Organs that have arrived at their full size possess a certain modifiability." (17) (This I would apply to the structural changes in the brain inevitable upon language learning as well as to those occurring through training or drilling in any art or trade involving manual dexterity or proficiency.)

"The growth of muscles exercised to an unusual degree is a matter of common observation. In the often cited blacksmith's arm, the dancer's legs, and the jockey's crural adductors we have marked examples of modifiability which almost every one has to some extent experienced. It is needless to multiply proofs. The occurrence of changes in the structure of the skin when exposed to a stress of function is also familiar. That thickening of the epidermis on a laborer's palm results from continuous pressure and friction is certain." * * * "An orchestral conductor gains by continual practice an unusually great ability to discriminate differences of sound, and in the finger reading of the blind we have evidence that the sense of touch may be brought by exercise to a far higher capability than is ordinary. The increase of power which habitual exertion gives to mental faculties needs no illustration, every person of education has personal experience of it." (18)

Language, therefore, may be regarded as pure gesticulation and its perfectibility as dependent upon the gradual evolution of the reasoning powers of animals. This being the case, it requires but a glance at the construction of the jargons of to-day (by courtesy called languages) to convince us of the very low plane to which man with his much vaunted intellect has arrived. From the teleological standpoint, certainly German with its nonsensical genders, French with its slaughter of letters for euphony sake, and English with its multitude of barbarisms, must have had more of a malign than divine origin. (But then the tower of Babel story accounts for it all.) Maudsley (19) mentions the inability of the Bosjesmen to talk in the dark, owing to their depending more upon signs than vocables for intercommunication. The North American Indians can thus converse without uttering a single sound. Laura Bridgeman may also be mentioned as expressing her thoughts, and even "muttering" in her dreams by finger motions. The necessity for such considerations as the foregoing appears in the philological bias which has crept into our physiological literature through the one-sided studies of such men as von Schlegel, and through their claims that the perfectly regular and complex construction of languages of many barbarous nations is a proof of the divine origin of language. By placing language upon an equal footing with all other voluntary gestures we see at once that speech is entitled to no more regard than any other set of complex motions performed by any animal to subserve rational purposes. We cannot deny the possession of rational language to animals when we see them conveying their thoughts and desires with and without sounds, by menaces, contortions, glarings, and a multitude of other movements. I have known mules and oxen on the arid plains of the West to acquaint a thirsty herd half a mile away that water has been discovered. All of us know of the hen's ability to talk to its chickens. The most perfect rhetoric and oratory of man can be said, therefore, to differ from these animal expressions only *in degree*, and often the most pretentious discourse conveys fewer ideas than the cluck of a hen or the growl of a dog. A pure linguist, hence, can claim but little more in an intellectual way than a pure gymnast. Different groups of muscles, nerves, bones, etc., are exercised and cultivated by each. Man can claim no more for developing adroitness in the use of his jaws, lips, tongue and larynx than any animal which, finding itself in possession of certain other limbs and groups of muscles turns them to the utmost possible advantage. The great function of the jaw was masticatory, its use

in enunciation of words was subsequently developed. The hands of our progenitors were adapted to climbing trees and by subsequent training are made dexterous in us in the use of tools. The point I desire to bring prominently into view is, that the speech faculty has for its basis nothing more important than prehensile abilities. The mechanic is entitled to the same amount of respect as the linguist; in fact, the mechanic is more apt to have acquired a respectable amount of skill in the use of his tools, as generally his labor is directed to some useful and definite end; not necessarily so with the linguist, his acquisition of a few jargons frequently causes him to be mistakenly regarded as intellectual. It is not the ability to use tools or to speak that elevates man above his fellow animals, for man is not the only animal that speaks or uses tools. The intellectual differences between men consist in the greater power of co-ordination and correlation of faculties.

Dr. M. Dax, in 1836, designated the left anterior lobe of the brain as the seat of language, because loss of speech often coexisted with disease of this part, though the labors of Bouilland previously had paved the way for this definiteness. Aubertin and Broca finally assigned this faculty as centralized in the "operculum," and Dr. Wm. A. Hammond (20), in reviewing the subject, concludes that: "The integrity of the posterior part of the third frontal convolution, and perhaps of the second, is indispensable to the normal operation of the function of speech." Hughlings Jackson, and Ferrier agree with Broca in restricting the location to the operculum, but Dr. Hammond (20) claims:

1. "That the organ of language is situated in both hemispheres, and in that part which is nourished by the middle cerebral artery.

2. "That while the more frequent occurrence of right hemiplegia, in connection with aphasia, is in great part the result of the anatomical arrangements of the arteries which favors embolism on that side, there is strong evidence to show that the left side of the brain is more intimately connected with the faculty of speech than the right."

I would like to suggest to the advocates of opercular and insular localization an idea which has probably not been previously advanced, to wit: The sinistral nature of central cerebral speech innervation has, doubtless, some relation to the azygous tendencies of the parts concerned therein; for example, the tongue, uvula, maxillæ, vocal cords, etc., though not strictly fused or impaired, present peculiarities of structure and synchronism of motion of the bi-laterally placed parts widely different from those of the extremities, which could easily influence innervation to centralize upon one side of the brain, particularly when favored by the better blood supply afforded by the left middle cerebral artery. Were the two hands of man joined so as to restrict motion mainly to a perpendicular plane, as in the case of the lower jaw, then we might expect the summit of the ascending frontal convolution on the left side to develop over the corresponding part on the right side as a centre for arm motions. But this matter of localization has not been firmly established. Dr. E. C. Spitzka, before the Medical Society of the County of New York in 1877, reviewed "The Localization of Cerebral Diseases in the Light of recent Anatomical Discoveries" (22). Spitzka acknowledged that "the fibres which ultimately abut in the hypoglossal and facial nerve nuclei can be traced into the operculum and island, giving us an anatomical basis for the aphasic symptom," but insisted that "our faculty of speech is certainly more complex than is generally supposed, and the terms amnesic and ataxic aphasia, by no means exhaust the possible pathological interferences with its delicate mechanism. The first step in the acquirement of speech is its phonetic element. We hear a word or sound, and as far as it is a mere sound impression it is registered in a sensory area of the cortex. We then experiment, as it were, with our motor apparatus, until we find the combination requisite to repeat said word or sound. This motor innervation has its conscious seat in Meynert's region, while the sensory perception is located in a distant area (probably, though not certainly) the occipital lobe. Now in order that the sensory perception may control the "correctness" of the motor expression the two must be associated. It will then be indifferent, whether the sensory center, the motor center, or the associating band be destroyed, we will have aphasia in either case. And there are still more intimate relations which may be equally interfered with, causing either aphasia, agraphia, alexia, or a combination of any two of these, or all." * * * "Any intricate intellectual processes *must* involve the greater part, or the whole, of one hemisphere." This was *a posteriori* completely, and "localizers" should not fail to read the proceedings of that meeting carefully. These views are consistent with the theory I recently presented to the American Neurological Society concerning the histogenetic function of nerve cells in opposition to their being "force producers." Spitzka has shown that the Island of Reil has nothing whatever to do with the development of the speech faculty. In some aberrant forms he found this lobe largely developed. It would seem that primarily this region has, if it have any connection at all with speech innervation, only a certain convenience of situation, an accidental contiguity to certain fasciculi which was taken advantage of as the speech faculty developed.

(1). Ziemssen's Cyclopædia.
(2). "Expression of the Emotions in Man and Animals."
(3). "The Brain as an organ of the Mind."
(4). "The Cat.'
(5). "On the Hypothesis that Animals are Automata and its history."
(6). Op. Cit.
(7). The Duke of Argyll, in *Nature*. See "SCIENCE," Vol. I, p. 24.
(8). "Anatomical uses of the Cat."
(9). Houzeau. "*Etude sur les facultés mentales des animaux comparées à celles de l'homme*, Mons. 1872. Bechstein "*Naturgeschichte der Hof und Stubenvogel*., C. G. Leroy, Intelligence and Perfectibility of Animals."
(10). "Are languages Institutions? *Contemporary Review*.
(11). "*Origine du Langage*," Chap. III.
(12). *Naturliche Schöpfungsgeschichte*."
13. Op. Cit.
(14). "*Ueber die Taubstummen*" *u. s. w. Schleswig*, 1853, *S.* 54.
(15). Carpenter's Physiology, p. 727.
(16). Principles of Biology, Vol. I., p. 157.
(17). Ibid, Chap. V., p. 184.
(18). Loc. Cit., p. 187.
(19). "Physiology of the Mind.
(20). "Diseases of the Nervous System," Seventh Edition, 1881, p. 182, *et seq*.
(21). E. C. Seguin, *Quarterly Journal of Psychological Medicine*, Jan. 1868.
(22). Journal Nervous and Mental Disease, Vol. IV, pp. 724-734.

ÆTHER.

By Pliny Earle Chase.

Professor of Philosophy in Haverford College, Pa.

The laws of æthereal action and re-action are laws of action and re-action in an elastic atmosphere.

The following well known laws have an important bearing upon photodynamics and other æthereal researches:

1. Cyclical activities may often be accurately represented by formulas which introduce mean or average ve-

locities and mean *vis viva*. This is the foundation of Maxwell's theory of the equality of mean *vis viva* in the molecular movements of different gases at equal temperatures, and of Pfaundler's discovery that in estimating the heat of dissociation, the mean should be taken between the temperatures of incipient and of complete dissociation.

2. The projectile force, which produces flight or cyclical motion against any central acceleration or retardation, is equivalent to the mean acceleration or retardation multiplied by one-half the time of flight or cyclical motion.

3. The velocities of wave motion in elastic fluids, and of cosmical and molecular orbital motion, can all be expressed by the common formula $v = \sqrt{2gh}$.

4. Every periodic vibrating or orbital motion can be regarded as the sum of a certain number of pendulum vibrations. (*Fourier's theorem.*)

5. The distance of the centre of oscillation from the centre of relative stability is at two thirds of the length of a linear pendulum, or at the square root of four tenths of radius in a rotating sphere.

6. The acceleration of any force, which is uniformly diffused from or towards a given centre, varies inversely as the square of the distance from the centre.

7. Times of revolution under the action of such forces, vary as the three halves power of the distance; distances vary as the two thirds power of the time.

8. Centres of inertia, or nodes, in a vibrating elastic medium, tend to produce harmonic nodes.

9. The mutual inter-actions of cosmical, molecular or atomic bodies are proportioned to the respective masses; actions which are considered with reference to a single active centre vary directly as the mass and inversely as the square of the distance.

10. In elastic atmospheres the densities decrease in geometrical progression, as the height above the surface increases in the arithmetical progression.

11. Living force, or *vis viva*, is proportional to the product of mass by the square of the velocity.

12. The distance of projection against uniform resistance is proportioned to the living force.

13. In condensing nebulæ, the velocity of circular orbital revolution is acquired by subsidence, from a state of rest, through one-half of radius.

The following additional propositions may be readily deduced from the foregoing.

14. *Mean vis viva* may be represented by the *vis viva* of centres of oscillation.

15. The force of planetary projection should be referred to perihelion; the force of incipient subsidence, to aphelion.

16. In synchronous orbits, the mean velocity of rectilinear oscillation is to the velocity of circular orbital oscillation as twice the diameter is to the circumference.

17. The acceleration or retardation of a centripetal force varies as the fourth power of the velocity of orbital revolution.

18. In cyclical motions, the resultant of all internal forces must be in equilibrium with the resultant of all external forces, at the expiration of each half cycle.

19. The modulus of cyclical motion is equal to the product of mean acceleration by the square of the time of a half cycle.

20. The sum of all external forces may, therefore, be represented by a velocity which is equivalent to the mean or resultant internal force acting for one-half of the cyclical time.

21. The influence of a central force which acts at the extremity of a linear pendulum is nine times as great upon the centre of oscillation, as its influence upon the centre of suspension.

22. The limiting *vis viva* of wave propagation is five-ninths of the mean *vis viva* of the oscillating particles.

23. In condensing nebulæ, rupturing forces which are due to central subsidence may be represented by fractions in which the denominator is one greater than the numerator.

24. In synchronous rotation and revolution, the nucleal radius varies as the three-fourths power of the limiting atmospheric radius.

25. The variation in mean *vis viva* of gaseous volume is to the variation in *vis viva* of uniform velocity as 1 is to 1.4232.

26. The mean thermal and mechanical influences of the sun must be in equilibrium.

27. The collisions of particles, in subsiding towards a centre of force, tend to form belts at the centre of linear oscillation.

28. The limiting velocity between tendencies to aggregation and tendencies to dissociation is to the velocity in a circular orbit as the ratio of the circumference of a circle to its diameter is to the square root of two.

29. In explosive, as well as in cyclical motions, equilibrium must be established between internal and external forces.

30. Apsidal and mean planetary positions must also be controlled by like tendencies to equilibrium.

31. Undulations in an elastic medium maintain the primitive velocity which is due to their place of origination.

32. When two or more cyclical motions are combined, they must all be modified by the tendency to conservation of areas.

33. In expanding or condensing nebulæ, the conservation of areas maintains a constant value for the modulus of rotation.

34. Instantaneous action between different masses or particles, by mere material intervention, is impossible.

35. In synchronous motions about different centres, the mean distances from the centres of motion vary as the cube root of the masses or other controlling forces.

36. Constant velocities, in a homogeneous elastic medium, represent constant living forces.

37. The time of acquiring orbital velocity, at Laplace's limit of possible atmosphere, is to the time of acquiring "nascent" or dissociative velocity at the nucleal limit, as the diameter of a circle is to its circumference.

These laws are applicable in all branches of radiodynamics, viz.: photodynamics, thermodynamics, electrodynamics, cosmodynamics, chemical physics, hydrodynamics and pneumatics.

COMET C, 1881.

At 3 A. M., of the 14th instant, a comet was observed at Ann Arbor by Mr. J. M. Schaeberle, an amateur astronomer, who has the privilege of the University Observatory.

Mr. Henry M. Parkhurst, of Brooklyn, whose recent calculations on comet B, 1881, proved to be very accurate, has published in the New York *Herald* the following observations on Mr. Schaeberle's comet:

"The position of the new comet on the 20th instant at 2h. 46m., Washington mean time, was:—Right ascension, 5h. 54m. 58s.; North declination, 40 degrees, 40 minutes. This shows a motion of 29 minutes per day—an increase of 7 minutes—showing that the comet is not so distant as I had hoped. I have not succeeded in reconciling my two positions with that telegraphed for the time of discovery. To satisfy the right ascension given the comet must have already passed its perihelion and be moving in such an orbit that it will pass between the earth and sun within a fortnight, and be no more seen in this hemisphere. The increased brightness this morning tends to support this idea. Yet it may not have reached its perihelion; in which case it may be visible for a month longer. I shall be compelled to wait for a third accurate observation before I can determine the orbit more exactly. In any event the comet is coming directly toward the earth, and it will become much brighter than at present, so that it will probably be visible to the naked eye as soon as the moonlight ceases to interfere. It is now about 12 degrees southeast of Capella, the bright star in the northeastern sky at 3 o'clock in the morning."

COMET B, 1881.

With the drawings of the above comet we received from Professor Edward S. Holden the following letter:

WASHBURN OBSERVATORY,
MADISON, WISCONSIN,
July 9, 1881.

To the Editor of "SCIENCE."

MY DEAR SIR—As you request, I send you with this, the drawings of the head of the bright comet which have been made here. The 15½-inch equatorial, with the zone eyepiece (field 25'.5, power 145), has been used. The drawings have all been made by me, and in them *the darker the shading, the brighter the corresponding part* of the comet.

Very sincerely yours,
EDWARD S. HOLDEN.

DESCRIPTION OF ILLUSTRATIONS.

Figure 1. June 24, 1881, 14h., m. t.
" 2. " 25, " 10h., m. t. Hazy and outlines of comet not well seen. The drawing shows only the structure of the head. The nucleus is not round, and is eccentric in the envelopes.
Figure 3. June 26, 1881., 11h., 22m., m. t. Hazy and clouds. The dark semi-circular line in upper part of nucleus represents a dark part.
Figure 4. June 27, 1881, 13h., m. t.
" 5. " 28, " 10h., m. t.
" 6. " 29, " 9h., 30m., m. t.
" 7. July 8, " 10h., 35 m.—Moonlight. The nucleus is not double. There is a dark, narrow channel between the following side of the nucleus and the envelopes, as in the figure.
Figure 8. July 11, 1881, 9h., 30m., m. t.—Strong moonlight and twilight.—In this figure, which is engraved differently to the others, the white part represents light, and the shading darker portions.

FIGURE 4.

Advices from Europe state that this comet was observed by Dr. Elkin, of the Royal Observatory, Cape of Good Hope, who states that after a week of overcast sky the comet was found there on May 31. Mr. L. A. Eddie, F.R.A.S., of Graham's Town, saw it on May 27, and others claim to have seen it two days earlier. On June 4 the tail was 6° long, coma 20 minutes, and nucleus 20 seconds in diameter; the comet was as bright as α Columbæ.

Mr. William Huggins states that "On Friday night, (June 24) I obtained, with one hour's exposure, a photograph on a gelatin plate of the more refrangible part of the spectrum of the comet which is now visible. This photograph shows a pair of bright lines a little way beyond H in the ultra-violet region, which appear to belong to the spectrum of carbon (in some form) which I observed in the visible region of the spectra of telescopic comets in 1866 and 1868. There is also in the photograph a continuous spectrum in which the Fraunhofer lines can be seen. These show that this part of the comet's light was reflected solar light.

FIGURE 3.

This photographic evidence supports the results I obtained in 1868, showing that comets shine partly by reflected solar light, and partly by their own light, the spectrum of which indicates the presence in the comet of carbon, possibly in combination with hydrogen."

The following spectroscopic notes, by W. H. M. Christie, of the Royal Observatory, Greenwich, will be read with interest:

With the Sheepshanks equatorial (6¾ inches aperture) the head showed the want of symmetry that has been remarked in some other comets. On June 24 the preceding side was much the brighter, there being a strong brush or

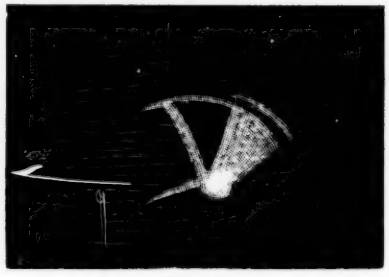

FIGURE 8.

arc of light on that side, with a bright fan close to the nucleus and a much smaller arc on the following side, the two arcs appearing to spring from the nucleus on opposite sides, and higher up to interlace. A very remarkable feature was a straight wisp of light extending from the nucleus nearly along the axis of the tail. On June 25 this had become much less striking, and the appearance of the head had entirely changed. The following side was then much the brighter, and the general appearance was that of a parabolic envelope, with a much brighter unsymmetrical parabola placed within it, the latter having its focus on the following side of the nucleus, and its axis turned round in the direction *n p s f* from that of the tail.

FIG. 5.

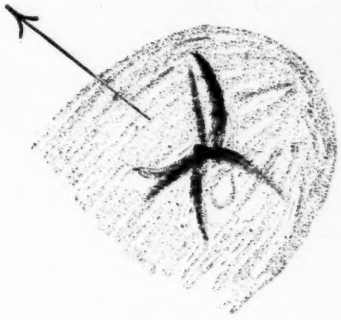

FIG. 2.

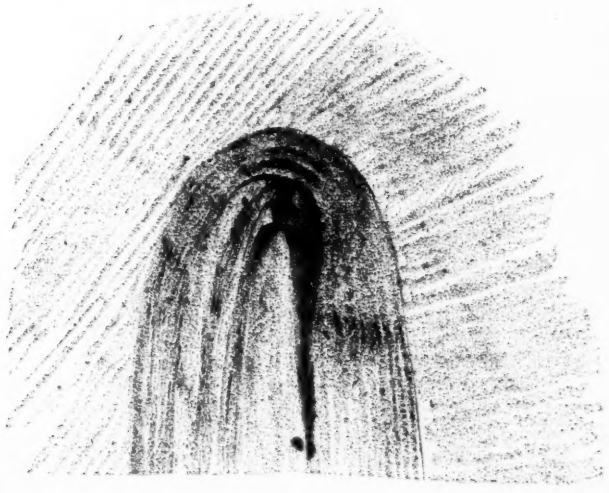

FIG. 1.

FIG. 7.

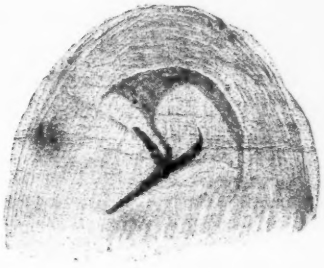

FIG. 6.

Drawings of Comet B, 1881, made by Prof. EDWARD S. HOLDEN, Washburn Observatory, Wis.

The greater part of the head gave a bright continuous spectrum, obliterating the usual cometary bands, but one portion showed three bands, in the green, blue, and violet respectively. Measures of the principal band in the green show that it coincides with the band in the first spectrum of carbon (blue base of flame) at 5165, and not with that of the second spectrum (vacuum-tube) at 5198. The bands in the blue and violet appear to correspond, as nearly as could be estimated, with bands in the first spectrum of carbon. These observations were made with the half-prism spectroscope mounted on the 12¾-inch equatorial, a dispersive power of about 18½° from A to H being used, with a magnifying power of 14 on the view-telescope, as in the measures of star-motions in the line of sight. No decided polarisation was detected either in the head or the tail. Cloudy weather has prevented any observation of the comet since June 25.

THE UNITY OF NATURE.

By the Duke of Argyll.

IX.

THE ORIGIN OF RELIGION CONSIDERED IN THE LIGHT OF THE UNITY OF NATURE.

(*Continued.*)

These conceptions seems to have taken their form from the very violence of the revulsion which they indicate and explain. The peculiar tenet of Buddhism, which is or has been interpreted to be a denial of any Divine Being or of personal or individual immortality, seems the strangest of all doctrines on which to recommend a life of virtue, of self-denial, and of religious contemplation. But the explanation is apparently to be found in the extreme and ridiculous developments which the doctrines of Divine Personality and of individual immortality had taken under the Brahminical system. These developments do indeed seem almost incredible, if we did not know from many other examples the incalculable wanderings of the human imagination in the domain of religious thought. The doctrine of the transmigration of souls at death into the bodies of beasts was a doctrine pushed to such extravagances of conception, and yet believed in with such intense conviction that pious Brahmins did not dare even to breathe the open air lest by accident they should destroy some invisible animalculæ in which was embodied the spirits of their ancestors. Such a notion of immortality might well oppress and afflict the spirit with a sense of intolerable fatigue. Nor is it difficult to understand how that desire of complete attainment, which is, after all, the real hope of immortality, should have been driven to look for it rather in reabsorption into some one universal Essence, and so to reach at last some final rest. Freedom from the burden of the flesh, rendered doubly burdensome by the repeated cycles of animal existence which lay before the Brahmin, was the end most naturally desired. For, indeed, complete annihilation might well be the highest aspiration of souls who had before them such conceptions of personal immortality and its gifts. A similar explanation is probably the true one of the denial of any God. A prejudice had arisen against the very idea of a Divine Being from the concomitant ideas which had become associated with personality. The original Buddhist denial of a God was probably in its heart of hearts merely a denial of the grotesque limitations which had been associated with the popular conceptions of Him. It was a devout and religious aspect of that most unphilosophical negation which in our own days had been called the "Unconditioned." In short, it was only a metaphysical, and not an irreligious, Atheism. But although this was probably the real meaning of the Buddhistic Atheism in the mind of its original teachers, and although this meaning has reappeared and has found intelligent expression among many of its subsequent expounders, it was in itself one of those fruitful germs of error which are fatal in any system of Religion. The negation of any Divine Being or Agency, at least under any aspect or condition conceivable by Man, makes a vacuum which nothing else can fill. Or rather, it may be said to make a vacuum which every conceivable imagination rushes in to occupy. Accordingly, Buddha himself seems to have taken the place of a Divine Being in the worship of his followers. His was a real personality—his was the ideal life. All history proves that no abstract system of doctrine, no mere rule of life, no dreamy aspiration however high, can serve as an object of worship for any length of time. But a great and a good man can always be deified. And so it has been with Buddha. Still, this deification was, as it were, an usurpation. The worship of himself was no part of the Religion he taught, and the vacuum which he had created in speculative belief was one which his own image, even with all the swellings of tradition, was inadequate to fill. And so Buddhism appears to have run its course through every stage of mystic madness, of gross idolatry, and of true fetish-worship, until, in India at least, it seems likely to be reabsorbed in the Brahminism from which it originally sprang.

And so we are carried back to the origin of that great Religion, Brahminism, which already in the sixth or seventh century before the Christian era had become so degraded as to give rise to the revolt of Buddha. The course of its development can be traced in an elaborate literature which may extend over a period of about 2000 years. That development is beyond all question one of the greatest interest in the history of Religion, because it concerns a region and a race which have high traditional claims to be identified with one of the most ancient homes, and one of the most ancient families of man. And surely it is a most striking result of modern inquiry that in this, one of the oldest literatures of the world, we find that the most ancient religious appellation is Heaven-Father, and that the words "Dyaus-pitar" in which this idea is expressed are the etymological origin of Jupiter Ζεύς πατήρ—the name for the supreme Deity in the mythology of the Greeks.

We must not allow any preconceived ideas to obscure the plain evidence which arises out of this simple fact. We bow to the authority of Sanskrit scholars when they tell us of it. But we shall do well to watch the philosophical explanations with which they may accompany their intimations of its import. Those who approach the subject with the assumption that the idea of a Divine Being or a Superhuman Personality must be a derivative, and cannot be a primary conception, allow all their language to be colored by the theory that vague perceptions of "The Invisible" or of "The Infinite," in rivers, or in mountains, or in sun and moon and stars, were the earliest religious conceptions of the human mind. But this theory cannot be accepted by those who remember that there is nothing in Nature so near to us as our own nature,—nothing so mysterious and yet so intelligible,—nothing so invisible, yet so suggestive of energy and of power over things that can be seen. Nothing else in Nature speaks to us so constantly or so directly. Neither the Infinite nor the Invisible contains any religious element at all, unless as conditions of a Being of whom invisibility and infinitude are attributes. There is no probability that any abstract conceptions whatever about the nature or properties of material Force can have been among the earliest conceptions of the human mind. Still less is it reasonable to suppose that such conceptions were more natural and more easy conceptions than those founded on our own personality and the personality of parents. Yet it seems as if it were in deference to this theory that Professor

Max Müller is disposed to deprecate the supposition that the "Heaven-Father" of the earliest Vedic hymns is rightly to be understood as having meant what we mean by God. Very probably indeed it may have meant something much more simple. But not the less on that account it may have meant something quite as true. I do not know, indeed, why we should set any very high estimate on the success which has attended the most learned theologians in giving anything like form or substance to our conceptions of the Godhead. Christianity solves the difficulty by presenting, as the type of all true conceptions on the subject, the image of a Divine Humanity, and the history of a perfect Life. In like manner, those methods of representing the character and attributes of the Almighty, which were employed to teach the Jewish people, were methods all founded on the same principle of a sublime Anthropomorphism. But when we come to the abstract definitions of Theology they invariably end either in self contradictions, or in words in which beauty of rhythm takes the place of intelligible meaning. Probably no body of men ever came to draw up such definitions with greater advantages than the Reformers of the English Church. They had before them the sublime imagery of the Hebrew Prophets—all the traditions of the Christian world—all the language of philosophy—all the subtleties of the Schools. Yet of the Godhead, they can only say, as a negative definition, that God is "without body, parts, or passions." But, if by "passions" we are to understand all mental affections, this definition is not only in defiance of the whole language of the Jewish Scriptures, but in defiance also of all that is conceivable of the Being who is the author of all good, the fountain of all love, who hates evil, and is angry with the wicked every day. A great master of the English tongue has given another definition in which, among other things it is affirmed that the attributes of God are "incommunicable."[4] Yet, at least, all the good attributes of all creatures must be conceived as communicated to them by their Creator, in whom all fullness dwells. I do not know, therefore, by what title we are to assume that "what we mean by God" is certainly so much nearer the truth than the simplest conceptions of a primeval age. It is at least possible that in that age there may have been intimations of the Divine Personality, and of the Divine Presence which we have not now. Moreover, there may have been developments of error in this high matter, which may well shake our confidence in the unquestionable superiority of "what we mean by God" over what may have been meant and understood by our earliest fathers in respect to the Being whom they adored. Some conceptions of the Divine Being which have been prevalent in the Christian Church, have been formed upon theological traditions so questionable that the developments of them have been among the heaviest burdens of the Faith. It is not too much to say that some of the doctrines derived from scholastic theology, and once most widely accepted in the Christian Church—such, for example, as the fate of unbaptized infants—are doctrines which present the nature and character of the Godhead in aspects as irrational as they are repulsive. One of the most remarkable schools of Christian thought which has arisen in recent times is that which has made the idea of the "Fatherhood of God" the basis of its distinctive teaching. Yet it is nothing but a reversion to the simplest of all ideas, the most rudimentary of all experiences —that which takes the functions and the authority of a father as the most natural image of the Invisible and Infinite Being to whom we owe "life and breath and all things." In the facts of Vedic literature, when we carefully separate these facts from theories about them, there is really no symptom of any time when the idea of some Living Being in the nature of God had not yet been attained. On the contrary, the earliest indications of this conception are indications of the sublimest character, and the process of evolution seems distinctly to have been a process not of an ascending but of a descending order. Thus it appears that the great appellative "Dyaus," which in the earliest Vedic literature is masculine, and stood for "The Bright or Shining One," or the Living Being whose dwelling is the Light, and in later times become a feminine, and stood for nothing but the sky.[5] It is quite evident that in the oldest times of the Aryan race, in so far as those times have left us any record, not only had the idea of a Personal God been fully conceived, but such a Being had been described, and addressed in language and under symbols which are comparable with the sublimest imagery in the Visions of Patmos. How firmly, too, and how naturally these conceptions of a God were rooted in the analogies of our own human personality, is attested by the additional fact that Paternity was the earliest Vedic idea of Creation, and Dyaus was invoked not only as the Heaven-Father, but specially as the "Dyaush pitâ ganitâ," which is the Sanskrit equivalent of the Greek Ζεὺς πατὴρ γενετήρ.

When, again, we are told by Sanskrit scholars that the earliest religious conceptions of the Aryan race, as exhibited in the Veda, were Pantheistic, and that the Gods they worshiped were "Deifications" of the Forces or Powers of Nature, we are to remember that this is an interpretation and not a fact. It is an interpretation, too, which assumes the familiarity of the human mind in the ages of its infancy with one of the most doubtful and difficult conceptions of modern science—namely, the abstract conception of Energy or Force as an inseparable attribute of Matter. The only fact, divested of all preconceptions, which these scholars have really ascertained is, that in compositions which are confessedly poetical the energies of Nature were habitually addressed as the energies of Personal or Living Beings. But this fact does not in the least involve the supposition that the energies of Nature which are thus addressed had, at some still earlier epoch, been regarded under the aspect of Material Forces, and had afterwards come to be personified, nor does it in the least involve the other supposition that, when so personified, they were really regarded as so many different beings absolutely separate and distinct from each other. Both of these suppositions may indeed be matter of argument; but neither of them can be legitimately assumed. They are, on the contrary, both of them open to the most serious, if not to insuperable objections. As regards the first of them—that the earliest human conceptions of Nature were of that most abstruse and difficult kind which consists in the idea of Material Force without any living embodiment or abode, I have already indicated the grounds on which it seems in the highest degree improbable. As regards the second supposition —viz., that when Natural Forces came to be personified each one of them was regarded as the embodiment of a separate and distinct Divinity—this is a most unsafe interpretation of the language of poetry. The purest Monotheism has a Pantheistic side. To see all things in God is very closely related to seeing God in all things. The giving of separate names to divers manifestations of one Divine Power may pass into Polytheism by insensible degrees. But it would be a most erroneous conclusion from the use of such names at a very early stage in the history of religious development, that those who so employed them had no conception of One Supreme Being. In the Philosophy of Brahminism even, in the midst of its most extravagant Polytheistic developments, not only has this idea been preserved, but it has been taught and held as the central idea of the whole system. "There is but one Being—no second." Nothing really exists but the one Universal Spirit, called Brahmin; and whatever appears to exists independently is identical with that

[4] J. H. Newman, "Idea of a University," p. 60.

[5] Hibbert Lectures, pp. 276, 277.

Spirit.[6] This is the uncompromising creed of true Brahminism. If, then, this creed can be retained amidst the extravagant Polytheism of later Hindu corruptions, much more easily could it be retained in the early Pantheism of the Vedic hymns.

There is, however, one kind of evidence remaining, which may be said to be still within the domain of history, and that is the evidence derived from language, from the structure and etymology of words. This evidence carries us a long way further back, even to the time when language was in the course of its formation, and long before it had been reduced to writing. From this evidence as we find it in the facts reported respecting the earliest forms of Aryan speech, it seems certain that the most ancient conceptions of the energies of Nature were conceptions of personality. In that dim and far-off time, when our prehistoric ancestors were speaking in a language long anterior to the formation of the oldest Sanskrit, we are told that they called the sun the Illuminator, or the Warmer, or the Nourisher; the moon, the Measurer; the dawn, the Awakener; the thunder, the Roarer; the rain, the Rainer; the fire, the Quick-Runner.[7] We are told further that in these personifications the earliest Aryans did not imagine them as possessing the material or corporeal forms of Humanity, but only that the activities they exhibited were most easily conceived as comparable with our own. Surely this is a fact which is worth volumes of speculation. What was most easy and most natural then must have been most easy and most natural from the beginning. With such a propensity in the earliest men of whom we have any authentic record to see personal agency in everything, and with the general impression of unity and subordination under one system which is suggested by all the phenomena of Nature, it does not seem very difficult to suppose that the fundamental conception of all Religion may have been in the strictest sense primeval.

But the earliest records of Aryan worship and of Aryan speech are not the only evidences we have of the comparative sublimity of the earliest known conceptions of the Divine Nature. The Egyptian records are older still; and some of the oldest are also the most sublime. A hymn to the rising and setting sun, which is contained in the 125th chapter of the "Book of the Dead," is said by Egyptian scholars to be "the most ancient piece of poetry in the literature of the world."[8] In this Hymn the Divine Deity is described as the Maker of Heaven and of Earth, as the Self-existent One; and the elementary forces of Nature, under the curious and profound expression of the "Children of inertness," are described as His instruments in the rule and government of Nature.[9] Nor is it less remarkable that these old Egyptians seem to have grasped the idea of Law and Order as a characteristic method of the Divine Government. He who alone is truly the Living One is adored as living in the Truth, and in Justice considered as the unchanging and unchangeable Rule of Right, in the moral world, and of order in the physical causation.[10] The same grand conception has been traced in the Theology of the Vedas. The result of all this historical evidence may be given in the words M. Renouf: "It is incontestably true that the sublimer portions of the Egyptian Religion are not the comparatively late result of a process of development or elimination from the grosser. The sublimer portions are demonstrably ancient; and the last stage of the Egyptian Religion, that known to the Greek end Latin writers, was by far the grossest and most corrupt."

[6] Professor Monier Williams, "Hinduism," p. 11.

[7] Max Muller, Hibbert Lectures, 1878, p. 193.

[8] Renouf Hibbert, Lectures, 1879, p. 197.

[9] Hibbert Lectures, by Renouf, pp. 198, 199.

[10] *Idem*, 1879, pp, 119, 120.

ANCIENT PLANETARY RINGS, VOLUME, MASS AND DENSITY.

By Edgar L. Larkin.

IV.

In Astronomical literature there is engrafted a venerable doctrine giving details of the processes of evolution of the solar system, from a mass of incandescent gas. The theory is a hundred years old. It says, all matter now in the sun and planets was once in a state of rare gas, extending beyond the orbit of Neptune. The gas was hot; it cooled, contracted, and rotated. When by condensation it had dwindled to the insignificant limits of the Neptunian orbit, its velocity of rotation was so great that a ring of gas was detached from the equator of the shrinking sphere. This ring in time formed Neptune. In like manner all the planets were formed, the residue of the primordial mass being the sun. This error has been taught to children, and so tenacious are the traditions of youth, that geometers have been known to cling to the illusion in mature years. It has but one rival—perpetual motion—and is known as the Nebular Hypothesis. If it is true it can be handled by arithmetic; if false, computation will detect the fallacy.

How shall it be attacked; and what can be learned of the primeval state of matter? Can we peer into the depths of primordial time when worlds were in development? The geologist penetrates strata, and writes the records of the earth. Can the history of Neptune be written? And can we trace the processes of its evolution? If so, the mass, volume and thence the density, of the ring whence it formed must be determined. We know its mass in terms of terrestrial matter, it was 102 sextillion tons, or 204 septillion pounds; because that is the amount of matter now in Neptune. By what possible means can its volume be learned? The problem seems incapable of solution, mathematics apparently being unable to furnish a method of grappling with the question. We have used diligence to find records showing that the volume and density of the ring have ever been calculated, and failed. But there is one way of learning the magnitude of the mass of gas whence Neptune condensed. It is based on the doctrine of the CENTRE OF GRAVITY, and it is a fact in nature which subverts the Nebular Hypothesis. We know that if the revolving sphere discarded equatorial matter to make Neptune, the planet formed in the line of its centre of gravity. There are formulæ for the determination of the distances of centres of gravity of segments from the centre of the circles whence they were cut. There are only three possible forms of rings that can be cut from the periphery of a sphere—segmental, cylindric and another, whose sections are in shape like sections cut by a perpendicular plane passing through a bi-convex lens. This geometrical figure is formed by the revolution of a segment of a circle about its chord held quiescent; and the solid generated is a circular spindle. This form we overlooked in the previous paper. The volumes of these rings are sought, the data being the distances of their centres of gravity from the centre of the sphere, which is the distance of Neptune from the sun—2,780,000,000 miles. It has been shown in these notes that the radius of the only sphere large enough to afford a segment of sufficient size to have its centre of gravity coincide with Neptune's orbit, was three (3) billion miles. The dimensions of this segmental ring cut off by passing the chord of the segment around the sphere, were: chord, 2,600,000,000; altitude, 300,000,000; and length, 17,500,000,000 miles, the length of the path of Neptune. Therefore its volume was nine (9) octillion cubic miles, and as this number of miles had to contain 204 septillion pounds, one cubic mile held .0224 pounds, or 157 grains, 45 cubic miles being required to contain one pound of gas.

"At 15.5° C, (60° F.), and 30 inches barometric pressure, 100 cubic inches of Hydrogen weigh 2.14 grains."

Fowne's Chemistry, p. 137. Thence one cubic mile of hydrogen weighs over five (5) trillion grains, or 777 million pounds. And as the ring was of such density as to require one cubic mile to contain 157 grains of matter, the Neptunian mass was thirty-four(34) billion times less dense than hydrogen.

The volume of the sphere, radius three (3) billion miles, whence Neptune was detached, the ring being segmental, was $\frac{4}{3}\pi R^3 = 113$ octillion cubic miles. But the ring was in volume nine octillion cubic miles, nearly $\frac{1}{12}$ the entire mass!

What unheard of convulsion took place to disrupt the mass and cause it to part with $\frac{1}{12}$ its bulk! What inconceivable power was displayed if the dogma is true, yet all the force present was gentle centrifugal tendency caused by slow rotations of 3.36 miles per second!

The mass of the first world is $\frac{1}{2000}$ of the solar system, but $\frac{1}{12}$ the volume was required to make it. The volume of a sphere bounded by the orbit of Neptune is $\frac{1}{6}\pi D^3 = 90$* octillion cubic miles, and as it contained 4 nonillion pounds of gas, each cubic mile held 44 pounds, —17,500,000 times less in density than the lightest body on earth, the mass being homogeneous. But it was not since the centre must have been compressed.

The density of the segmental ring was 34 billion times less than hydrogen, therefore, the sphere was old when it cast away its first world, having had time to acquire internal density, greater than peripheral, in the proportion of 17 millions to 34 billions. All along we have been quoting Helmholtz, where he says:—"It required several cubic miles to weigh a single grain,"—not having made calculation, but now we do not see how he arrived at these results, as one cubic mile, by following the principle of centre of gravity, is found to have contained 157 grains.

He probably alluded to the mass when expanded larger; but if extended to half the distance of the stars, a thousand cubic miles might have been required to contain one grain of matter. And we feel that we are traversing solid ground, in basing these deductions on the doctrine of the centre of Gravity. The volume of a cylindric ring to form Neptune must have been the same as the segmental, the density being nearly equal. The diameter of a section of a cylindric ring whose length was equal to that of Neptune's orbit, in order to have the required volume, was 822,000,000 miles. Since the planet coalesced in its centre of gravity, which was its geometrical centre, the material of the ring extended 411,000,000 miles above, and the same distance below the orbit. This added 822,000,000 miles to the equatorial diameter of the mass, retarded its assumed rotation, and prevented detachment of any particle of matter. The disrupting force had to be applied, not where Neptune revolves, but 411,000,000 below, at a point where force was weakest, and resistance strongest. And then such a ring was subjected to lateral pressure, and could not be severed on that account.

The ring made up of an infinite number of solids generated by revolution of circular segments about their chords, to have the same volume as segmental and cylindric, was in radial diameter 380,000,000, and in diameter north and south 2,090,000,000 miles. If this form of ring was discarded the break took place 190,000,000 below the orbit, and along a line more than two billion miles long. Rotation was slower than the orbital velocity of Neptune, and the separation was again required to be made where the force to cause it was in minimum, and its opposing powers, gravity and cohesion, at a maximum. We reassert that in no possible case could the Neptunian matter have been detached from the primeval mass when it was a *sphere*.

Neither could it have been separated when sections of the protuberance were parabolic; thus a chord, or limiting plane, the base of a parabolic segment, in order to cut out a ring in volume sufficient to contain the Neptunian gas, was in length 634,000,000, in altitude 1,250,000,000, the vertex extending 750,000,000 above, and base descending 500,000,000 miles below, the orbit, in order that Neptune might condense in its centre of gravity. This would make the equatorial diameter of the mass 7,060,000,000 miles a physical impossibility, for rotation would have come to a dead rest ages before such elongation. Consider the curvature of sections semi-elliptical and results are still more absurd. Since the mass was unable to part with rings whose sections were hyperbolic, parabolic or semi-elliptic, we dismiss as untenable all varieties of such ring-shaped masses.

Now conceive the mass a sphere again and at rest; let rotary motion be imparted, and should the velocity become sufficient, the equatorial regions will become a swelling tide. But when a protuberance elevated motion waned, and the equator subsided. When at greatest altitude the whole mass was an ablate spheriod. Therefore, we lay down this proposition which must have obtained if the Hypothesis of ring displacement is true. If the equatorially expanding mass parted with a ring, it did so at the first opportunity.

And such fullness of time was when a segment of an ellipse could be cut away large enough to have Neptune in its centre of gravity. When the mass was an ablate spheroid, sections cut by passing planes through the entire mass, at right angles to the equator, bisecting the poles, would all be plain curves—ellipses. And a segment severed from the equator to make Neptune, was a segment of an ellipse, whose centre of gravity coincided with that planet's present track. The dimensions of this ring were, height, 319,000,000, and chord 2,350,000,000 miles, to have volume sufficient, to contain gas enough to solidify into the most remote member of the solar system. The axes of the ellipse whence this segment was cut were transverse, 5,800,000,000, and conjugate, 5,400,000,000, the diameter of the mass when spherical being 5,560,000,000 miles. Therefore, we say that during all mutation in form of the primordial cosmical mass, admitting the hypothesis true, its equatorial diameter was never augmented more than 240,000,000 miles, as is seen in these dimensions.

Mathematical instruments of delicacy are required to measure such small deviation from a sphere. Yet, it was able to discard a ring having a volume of nine octillion cubic miles. Basing conclusions on the sure foundation of the principle of the centre of gravity, we assert that the mass never detached rings whose sections were of any form of curvature known to geometry. Then none were cast off, since every department of celestial mechanics is known to be subject to rigid mathematical laws.

The theory of cosmic evolution, which holds that planets were formed of masses detached from an aeriform sphere belongs in that list of delusions which retarded the early progress of astronomy—the "Geocentric System," the "Firmament," and "Music of the Spheres."

NEW WINDSOR, ILL., *July* 10, 1881.

* Ninety Octillion.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

To the Editor of "SCIENCE":—

Dr. J. J. Mason in his second rejoinder to the criticism made by a reviewer in SCIENCE, leaves his unknown critic to the contemplation of the latter's clause. "Notwithstanding the construction which Dr. J. J. Mason now desires to see placed on his words," and does him "the justice" of supposing that the critic

knows what he insinuated. This the critic did indeed know! In view of the inconsistency between the text of his article, and the *dementi* of his first rejoinder, he considered himself justified in insinuating that Dr. Mason had come to recognize that one of his views was untenable, and preferred to deny having entertained that view to admitting its errors publicly. If I have misinterpreted Dr. Mason's paper, I fail to see it even now, for the doctor fails to answer my question: What other than the size of the cells and their nuclei, does Dr. Mason refer to when he speaks of a structure universally admitted to be motor?" Until he answers this, I would suggest that further correspondence on this head is a waste of the space in your periodical, and that demands for "customary regrets" are premature. I am as willing now as I have been throughout not only to withdraw my original stricture, but also the statements that have grown out of the controversy, if Dr. Mason can explain this passage and those with which it is associated, differently from my interpretation, and the meaning evident on their face.

Such an explanation should, however, avoid the incongruity existing between the text of Dr. Mason's article and the explanation he now gives of his real intention in polemicizing against Stieda, which I must confess I have not been able to assimilate. Dr. Mason might also answer this question. Why has he, if his "three brief articles" relate throughout to reptiles, and Batrachians referred to the bat as bearing out his theory, and why has he incorporated an explanation as his own, which I published two years before, without even mentioning my name, or that of some one else who may have anticipated me? My publication was certainly known to Dr. Mason, and he cannot fall back upon the flimsy excuse that it was a "preliminary" communication, and had nothing to do with his subject. If the explanation was worth while incorporating in Dr. Mason's paper, it was worth while giving its author credit for it, just as it was worth while referring to the author of the Iguana article by name, if it was worth Dr. Mason's while to offer suggestions in a patronizing way, which were altogether unnecessary as a matter of instruction, and as which they seem intended to appear.

I consider this subject closed, as far as I am concerned, until such time as the main question here repeated, is properly answered.

E. C. SPITZKA.

NEW YORK, 130 E. 50th Street, July 19, 1881.

NOTES.

The *Chemiker Zeitung* states that all the English and French professors at the University of Yeddo, Japan, have been dismissed, and their places filled with Germans. The Japanese Minister of Public Instruction is a German professor. The Chinese are about establishing a German University at Pekin. These facts should be duly weighed by those who still doubt the superiority of German research over English cram and examinations!

ACCORDING to M. A. Gaudry the Permian reptiles of France diminish the vast interval which exists at present between the reptiles and the monotrematous mammals.

THE ferment which M. Béchamp supposed he had discovered in chalk has been traced, by MM. Chamberland and Roux, to an experimental error.

METEOROLOGICAL REPORT FOR NEW YORK CITY FOR THE WEEK ENDING JULY 16, 1881.

Latitude 40° 45′ 58″ N.; Longitude 73° 57′ 58″ W.; height from ground, 53 feet; above the sea, 97 feet; by self-recording instruments.

JULY.	BAROMETER. MEAN FOR THE DAY. Reduced to Freezing.	MAXIMUM. Reduced to Freezing.	MAXIMUM. Time.	MINIMUM. Reduced to Freezing.	MINIMUM. Time.	THERMOMETERS. MEAN. Dry Bulb.	MEAN. Wet Bulb.	MAXIMUM. Dry Bulb.	MAXIMUM. Time.	MAXIMUM. Wet Bulb.	MAXIMUM. Time.	MINIMUM. Dry Bulb.	MINIMUM. Time.	MINIMUM. Wet Bulb.	MINIMUM. Time.	MAXI'M In Sun.
Sunday, 10	30.044	30.094	9 a. m.	29.982	12 p. m.	72.6	68.6	82	4 p. m.	74	4 p. m.	66	4 a. m.	65	4 a. m.	124.
Monday, 11	29.943	29.996	12 p. m.	29.900	2 p. m.	72.0	69.3	80	11 a. m.	74	11 a. m.	65	12 p. m.	63	12 p. m.	129.
Tuesday, 12	29.956	30.000	9 a. m.	29.900	12 p. m.	69.7	65.7	76	4 p. m.	70	5 p. m.	63	4 a. m.	62	5 a. m.	131.
Wednesday, 13	29.805	29.900	0 a. m.	29.744	6 p. m.	79.6	73.6	90	4 p. m.	80	4 p. m.	68	3 a. m.	66	3 a. m.	135.
Thursday, 14	29.889	29.976	12 p. m.	29.794	0 a. m.	80.0	71.3	86	3 p. m.	74	2 p. m.	75	6 a. m.	69	6 a. m.	143.
Friday, 15	30.002	30.022	9 a. m.	29.976	0 a. m.	76.3	69.7	82	3 p. m.	72	1 p. m.	70	12 p. m.	67	6 p. m.	138.
Saturday, 16	29.801	29.984	0 a. m.	29.618	12 p. m.	78.6	71.6	83	3 p. m.	73	3 p. m.	69	5 a. m.	67	5 a. m.	134.

			Dry.	Wet.
Mean for the week	29.920 inches.	Mean for the week	75.5 degrees	69.9 degrees.
Maximum for the week at 9 a.m., July 10th	30.094 "	Maximum for the week, at 4 pm. 13th	90. "	at 4 pm 13th, 80. "
Minimum " at 12 pm., " 16th	29.618 "	Minimum " " 4 am. 12th	63. "	at 5 am 12th, 62. "
Range	.476 "	Range " "	27. "	18. "

JULY.	WIND. DIRECTION. 7 a. m.	2 p. m.	9 p. m.	VELOCITY IN MILES. Distance for the Day.	FORCE IN LBS. PER SQR. FEET. Max.	Time.	HYGROMETER. FORCE OF VAPOR. 7 a. m.	2 p. m.	9 p. m.	RELATIVE HUMIDITY. 7 a. m.	2 p. m.	9 p. m.	CLOUDS. CLEAR, 0 OVERCAST, 10 7 a. m	2 p. m.	9 p. m.	RAIN AND SNOW. DEPTH OF RAIN AND SNOW IN INCHES. Time of Beginning.	Time of Ending.	Duration. h. m.	Amount of water	OZONE.
Sunday, 10	s.	s.	s.	98	¾	3.30 pm	.577	.704	.668	84	73	85	10	2 cir. cu.	3 cir.	-----	-----	-----	--	0
Monday, 11	s. w.	s.	e. n. e.	106	11¾	11.30 am	.668	.799	.591	85	86	89	10	10	10	0.15 pm	2.00 pm	1.45	.09	2
Tuesday, 12	e. n. e.	e.	s. s. e.	113	¼	5.30 pm	.516	.604	.622	83	72	85	9 cu.	5 cu.	5 cu.	10 pm	11.30 "	1.30	.02	0
Wednesday, 13	s. s. w.	w. s. w	w. s. w.	137	2¾	2.00 pm	.644	.836	.787	85	65	74	10	0	3 cu.	4.00 pm	5.00 pm	-----	--	4
Thursday, 14	n. w.	n. n. w.	n. w.	122	1½	9.30 am	.601	.691	.664	65	57	69	0	3 cir. cu.	8 cu.	-----	-----	1.00	.01	1
Friday, 15	e. n. e.	e. s. e.	s. s. e.	130	3¾	10.00 am	.568	.677	.666	68	66	77	6 cir.cu	9 cir. s.	0	-----	-----	-----	--	0
Saturday, 16	s. w.	s. w.	w. s. w.	135	3¾	4.40 pm	.655	.677	.717	81	60	70	1 cir.	6 cir. cu.	0	-----	-----	-----	--	7

Distance traveled during the week	841 miles.	Total amount of water for the week	12 inch.
Maximum force	11¾ lbs.	Duration of rain	4 hours 15 minutes.

DANIEL DRAPER, Ph. D.

Director Meteorological Observatory of the Department of Public Parks, New York.